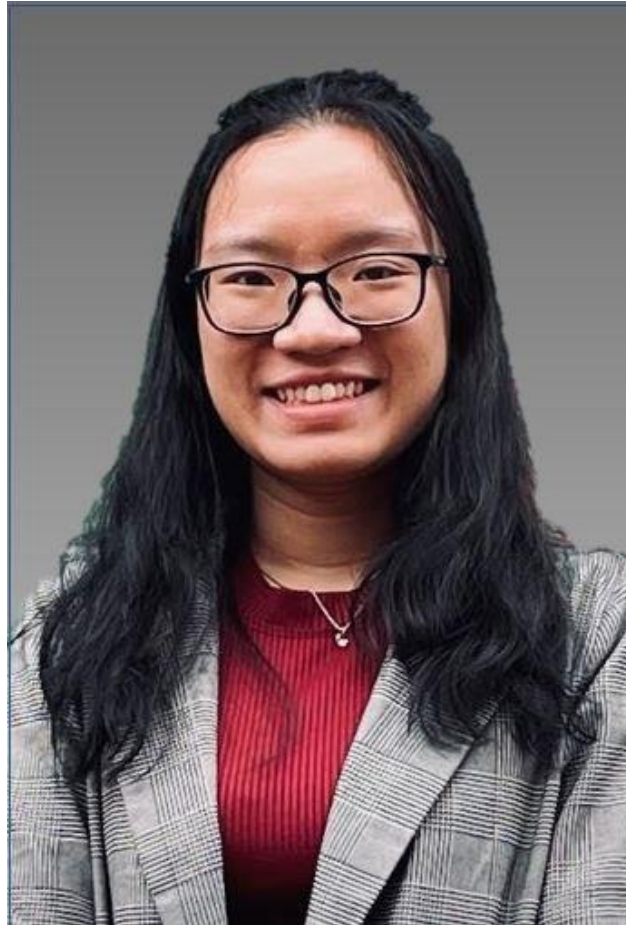


# About Mai Khuc



My name is Mai Khuc, and I am a Mechanical Engineering major with minors in Engineering Entrepreneurship and Sustainability Studies from the Class of 2022.

Since middle school, I have always been interested in renewable energy, especially solar energy since this particular source of energy is abundant in Vietnam, my home country. Meanwhile, Vietnam still suffers from air pollution, most of which come from burning fossil fuels for industrial manufacturing and transportation. Moreover, many people in Vietnam still live without reliable access to electricity, especially those who live in the rural area where it is technically difficult and uneconomical to extend the grid to. Therefore, I believe there is a strong market for solar energy in Vietnam, and one of the main entry barriers for most people is the cost. By making solar energy cheaper and thus more accessible to the population, I can help not solving one of the most critical environmental problems in the country, but also improving the living standards for a lot of people. Other countries, especially developing ones, can also be benefitted from my work as well, since a lot of them are facing the same problems. Therefore, through making solar energy more affordable, I hope I would be able to help these countries socially, economically, and environmentally.

## Research/Creativity



For my research portion, I worked on a project where I compare the capital cost between using new and used batteries for a solar home system. For every solar home system, batteries account for a significant percentage of the upfront cost, creating barriers to entry for a lot of homeowners, especially those with limited financial means in developing countries. Moreover, most batteries are still being made from materials that is both limited and harmful to both the ecosystem and human, thus reusing and recycling batteries is beneficially economically and environmentally. I was fortunate to be able to work with Dr. Primal Singh and Brandon Simons, a Sustainable Engineering graduate student throughout this project.

During the research, our goal was to build battery packs for solar home systems in rural Fiji for families that have Tier 2 energy access as defined by the World Bank criteria. To do so, we charged and discharged old car batteries several times to determine their real capacity. After that, they were put into different packs based on their capacity, since the whole pack would behave similar to the worst. These battery packs were tested again for us to see if our predicted capacity was true. We also did solar calculations for these solar home systems to determine the needed battery capacity. Finally, we compare the cost between used batteries and new ones, as well as energy cost from solar home system to energy cost from the grid.

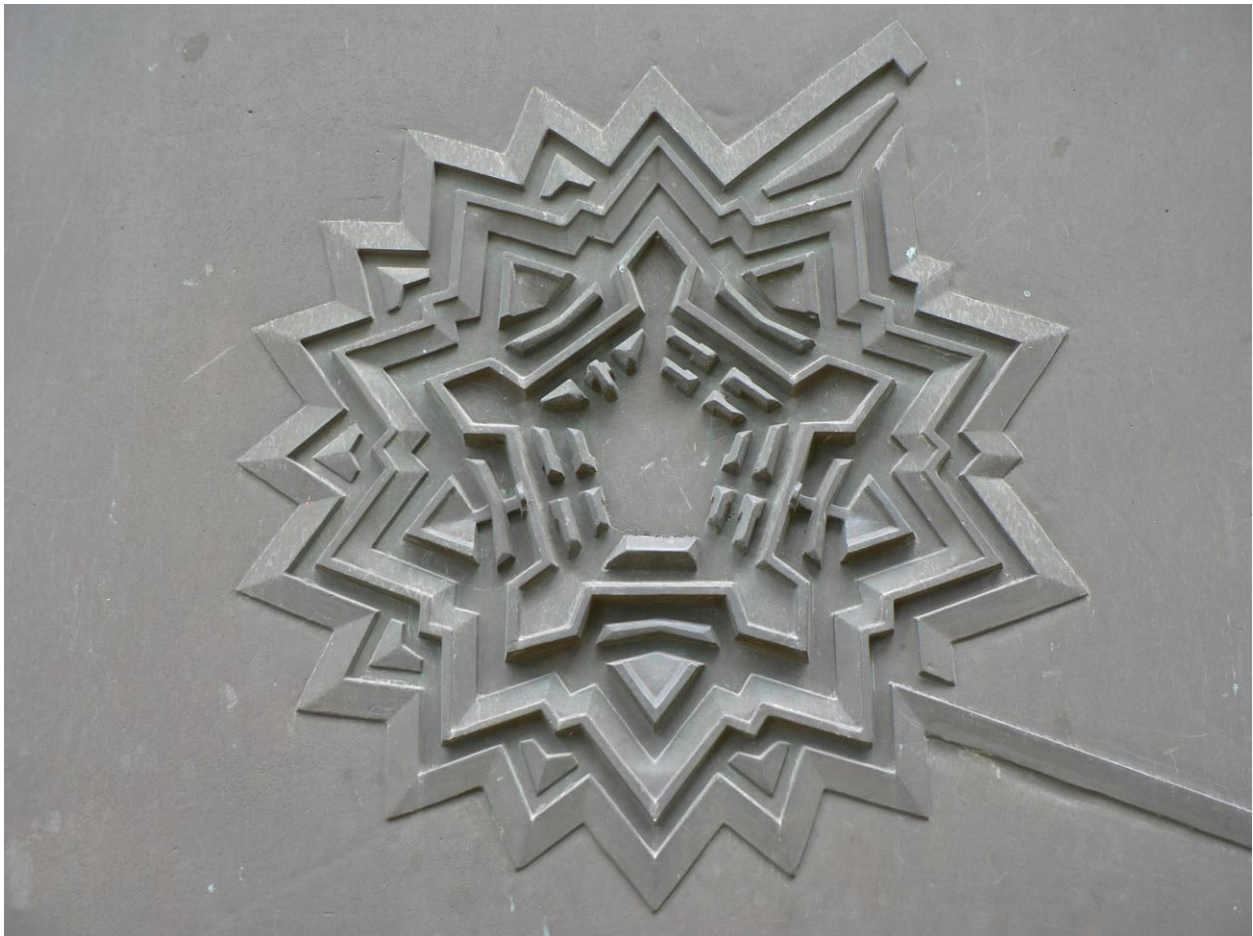
Throughout the research, I have learned a lot about batteries, which is something I have not really gotten to learn in class even though they are an essential part in any renewable energy system. Besides getting to know the meaning of many battery-related terminology, I have also learned how to conduct research properly and effectively, specifically how to design my test to find out what I want to know about. I have also gotten to do solar calculations and capital cost calculations, and it is interesting to see that it actually only costs a few hundred dollars to supply an entire house with basic electricity access for



over 20 years. As many of us are enjoying the convenience of advance technology, there are still a lot of people having to live without reliable access to electricity. Seeing for myself that it takes just a little effort to make a difference in someone life has encouraged me to continue with what I have been trying to do.

I believe projects like these have a lot of potential for real life application, and I hope that the system we were working on will one day be deployed, not only in Fiji but all around the world for anyone who needs it.

## Multidisciplinary Solutions



Alongside with my Engineering Entrepreneurship minor, I also have a minor in Sustainability Studies where I take classes from three categories: Science and Technology, Humanities, and Policy. These classes give me insights on how the environmental and energy issues are viewed from different perspectives, and why collaboration between all fields are required if we want to solve these problems.

One of my most favorite classes is Intro to Sustainability Studies, where I got to learn about both the theory and the application of different energy sources. Specifically for solar energy, we discussed in depth the working principles of a solar cell, which answer why current solar panels are designed the way they are currently and what else can be done in the future to improve their efficiency. We also talked

about newer solar panels designs such as the thin film solar cell and building integrated photovoltaics. Not only are these new designs more efficient, versatile, and aesthetic, but they also use less materials to generate more electricity, helping to reduce the cost of energy even further in the future. After having some hand on experience on the fields with solar panels, it is very interesting to go back into the classroom and learn about how people came up with these ideas in the first place. We also learned about the pro and con of different solar systems designed and how to maximize the solar output for different scenarios. This knowledge will become especially helpful for me in the future in optimizing the output power on a fixed construction cost, lowering the electricity price for the user.

I also took some class with the Geography and Environment department throughout my minor. In Intro to Sustainability Studies, we looked at renewable energy from an environmental science/policy making perspectives. We learn about energy systems as integral parts of a sustainable community, how they interact with other systems, and what can be done to make the whole community the most ecofriendly possible while still being efficient. I also took a class in Environmental Security and learned the importance of policies and regulations on sustainability movement, and how us as individuals and help progress these changes. I have also had a chance to discuss the change in human's perspective of nature in my Environmental Ethics class, how we go from view the environment as something to be exploited and conquered to an essential part of the community that needs to be respect and taken care of. Overall, this minor has given me a multidisciplinary approach to solving environmental issues in general and energy issues specifically, which are all extremely important as I try to make solar more economical for everyone, which definitely requires collaboration between many different fields.

## Business/Entrepreneurship



Besides studying for my major and doing research, my teammates (or my co-founders in this case) and I spent a lot of time building our ventures throughout the 2-and-a-half year Engineering Entrepreneurship minor. In this minor, we came up with ideas for our potential products, researched potential markets, worked through the details about the business models and product designs, made sure our business follows the laws and regulations, applied for a provisional patent, and pitched our business to a group of investors. Throughout this process, I have learned a lot about how to successfully establish and run a business, and at the end of the day, a lot of strategies are used in entrepreneurship to make the system

more efficient and reduce cost, and I can definitely learn a thing or two from them trying to make solar energy more economical.

A huge part of the minor at Villanova is guest speakers. In those 5 semesters, we have had opportunities to meet with numerous entrepreneurs from many different industries. They told us their stories of how they became an entrepreneur, what obstacles they overcame, and gave us a lot of advice from both their successes and failures. I have learned from them not only perseverance but also creativity, since many of them try to solve the same problems using different approaches, which inspires me to be more innovative in solving any problems.

Besides that, I got to work with great teammates throughout my project. We actually had to pivot a few times throughout the minor because we learned that our products is not the most suitable for the current market. While it was a lot more work than sticking to the same project, we actually got to learn a lot more about different market and different business models corresponding to different products. We also learn how to be flexible and realize when it is time to change direction. There are also a million things behind the scenes when building a business that no one talks about, and we got to experience that first handedly. We also had to put together a pitch for the investors, and that taught us a lot about describing our ideas, engaging with the audiences, persuading other people to buy into our business venture. Whether or not I become an entrepreneur in the future, I believe these skills and connections that I have gained throughout the minor has definitely helped me a lot throughout my college career and I have no doubt that they will be just as useful for me in the future.

## Global/Multicultural Experience



During the fall semester of my junior year, I was fortunate enough to have the opportunity to intern with the Project Engineer Department of SolarBK, one of the leading EPC firms for commercial and residential solar projects in Vietnam. Since their establishment, SolarBK has installed over 650MW of solar panels, including an integrated off-grid energy system at the Spratly Islands.

Over my internship, I got to shadow the engineer throughout all phases of a commercial solar project ranging from 300kW to 1MW which is a big step up from the residential scale that I am used to during my service trip and research. I followed the engineers to the site and learned how to take all the necessary measurement for the preliminary simulation. After the contract is signed, I got to help with all the detailed design documents, including the PV panels layouts, the wiring diagrams, the mechanical structural designs, and the bills of materials, all while making sure that everything is in compliance with multiple regulations and laws. I have always learned how to maximize the energy output, which includes optimizing the PV panels configurations and minimizing wiring distance to reduce the voltage drop. These optimizations definitely help reduce the cost per kWh as well, and while it does not seem like a lot, the client can save a significant amount over the project lifetime of 20 years, especially with systems that are as large as 1MW.

I also got to meet many young people who are aspiring to make solar energy more accessible to everyone. I have also got to meet the CEO of SolarBK, who quit his job as a college professor and founded the company almost 15 years ago. They have been through a lot of difficulties, especially during the earlier years when solar panels were not as popular and significantly more expensive than



conventional energy sources at the time. 15 years later, not only that they have multiple offices in different locations throughout Vietnam, but they have also built 2 factories to manufacture their own solar panels. They also keep trying to improve their panels' performance through a lot of funding into the internal R&D department. They have made me both proud and hopeful for the future of energy in Vietnam as so many people are committed to bring green energy to the community.



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## Social Consciousness



One of my best memories during my freshman year was the service trip to Salinas, CA over the spring break where we helped install solar panels in low-income communities with the Villanova Campus Ministry. I signed up for that trip mainly because it directly related to solar energy, and while I knew the trip would be much more than just about the actual construction, I had no idea how the trip would change both my mind and my heart.

To begin with, I doubt there would ever be any college course that can teach me more about solar panels construction and installation than four days of actually putting those panels on people's roofs. Our team was lucky enough to be able to follow the GRID team throughout every stage of the construction, from taking measurements of the roofs, designing, to installing the solar panels. The most exciting part was definitely the installation. We also gained new construction skills, both technical skills such as wiring and handling construction tools to soft skills such as communication and team working. The GRID members were very helpful in explaining what exactly we were supposed to do, and they were doing an amazing job considering how none of us had any prior experience working at construction sites.

Over the trip, I got to meet some of the most amazing people in my life as well. While none of us knew each other before and we barely met before the trip, to my pleasant surprise, it only took us a flight and a lunch for everyone to get to know each other, and we all became very close friends over the week. We also got to talk to a lot of homeowners who we helped out over the week. Granted, we did not stay with the homeowners that we were helping like some other groups, but just spending time listening to their story was more than enough for us to understand that we were extremely fortunate compared to most other people. The homeowners were all extremely welcoming to all of us, and I do not think that I could ever forget how excited they were telling us how much the solar panels would help them or their home-cooked meals for all of us.

We were also all extremely impressed with all the GRID team members, especially after spending four days with them and seeing how much effort everyone was trying to serve as many people as possible with such limited means. We never thought that those people would be saying thank you to us at the end of the trip, telling us that we reminded them of themselves a few years ago - unprofessional yet eager to help - and reignited the service spirit among the GRID team members again. While we definitely were not able to help as many people as we wanted to, the homeowners' gratitude had made us feel better about ourselves and wanted to do more, and the GRID team had been a living proof to show that something started small could become bigger.



